ICE MACHINE WITH REMOTE MONITORING

CROSS-REFERENCE TO RELATED CASES

This application claims priority to U.S. Provisional Patent Application No. 60/417,468, filed on October 10, 2002.

1. Field of the Invention

The present invention relates to the field of ice machines. Specifically, the present invention relates to ice machines whose operation is monitored via electronics which in turn communicates the ice machine's operational status and ice production history to a remote computer.

2. Background of the Invention

Commercial ice making machines are used in restaurants, bars, hotels, schools, stadiums, arenas, grocery stores and the like. Such machines are typically mounted on top of an ice bin or an ice dispenser that is kept full of ice by the machine.

Commercial ice making machines come in a wide variety of types and production capacities so that the customers for such machines can buy one that closely matches his or her application. Because there is such a wide array of machine choices, it is possible for an ice machine customer to minimize the amount of money he must spend on the initial purchase by picking the machine that makes just enough ice for his application. Unfortunately, this can result in an ice machine that is outgrown quickly if the owner's ice-needs increase. Because all of the major manufacturers of ice making machines offer the same wide variety of ice machine models, they all experience additional costs associated with manufacturing, stocking, selling, servicing and providing parts for a huge array of machines.

All commercial ice machines require regular maintenance. For example, manufacturers typically recommend cleaning the machines a minimum of every six months. Besides this regular maintenance, over the life of an ice machine (typically 7 to 10 years) it is not uncommon for an ice machine to break down such that the a repairman must be called to fix the machine. Typically a broken machine will be noticed when the bin runs out of ice, and does not fill back up. At this point the establishment must not only call for service, but must also go purchase ice since at this point they are completely out. They must continue to purchase ice until the machine is back up and running.

Summary of the Invention

A system for monitoring the status and/or ice production of an ice making device, the system comprising: at least one detector for determining the status and/or ice production of the ice making device, thereby producing detected status and/or ice production data; a microprocessor; and a transmitter for communicating detected status and/or ice production data from the detector to the microprocessor. The system may optionally also include an additional transmitter for communicating the detected status and/or ice production data from the microprocessor to a service provider.

The service provider is at least one provider selected from the group consisting of: ice making device repair provider, ice making device manufacturer, leasing agent and ice supplier.

The transmitter and additional transmitter are at least one selected from the group consisting of: Internet, wired telephony, wireless telephony, cable, and any other device capable of communicating the status and/or ice production data from the detector to the microprocessor and/or from the microprocessor to the service provider.

The detector preferably comprises: a first sensor for determining if the ice storage bin switch is either opened or closed; a second sensor for determining if the hot gas valve is on or off; a microprocessor for determining the freeze and/or harvest times for the ice making device to freeze and/or harvest ice during an ice making freeze/harvest cycle and/or number of the freeze/harvest cycles; and a data generator which is capable of producing the status and/or ice production data. The status and/or ice production data is at least one selected from the group consisting of: freeze cycle time, harvest cycle time, count of completed freeze/harvest cycles, and ice making device fault alert. The ice making device fault alert is at least one selected from the group consisting of: freeze time exceeded the predetermined maximum freeze time limit, freeze time is less than the predetermined minimum freeze time limit, harvest time exceeded the predetermined maximum harvest time limit, or harvest time is less than the predetermined minimum harvest time limit.

The status and/or ice production data communicated to the microprocessor is at least one selected from the group consisting of: identification of the ice making device, cycle time for the ice making device to complete a freeze and/or harvest cycle, the number of cycles which the ice making device has completed during the detection period, and status of the ice making device.

The microprocessor is capable of transmitting at least one data selected from the group consisting of: identification of the ice making device, location of ice making device, owner contact information, cycle time for the ice making device to complete a freeze and/or harvest cycle, the number of cycles which the ice making device has completed during the detection period, other operation data, status of the ice making device, operational history of ice making device, identification of parts likely to be needed to repair ice making device, and probable cause of alert problem.

An additional embodiment according to the present invention pertaining to a method for monitoring the status and/or ice production of an ice making device, the method comprising: determining the status and/or ice production of the ice making device, thereby producing detected status and/or ice production data; and communicating the status and/or ice production data from the detector to a microprocessor.

Still yet another embodiment according to the present invention includes a method for monitoring an ice making device comprising a bin switch and a hot gas valve, the method comprising: determining if the bin switch is either opened or closed; determining if the hot gas valve is on or off; determining the freeze and/or harvest times for the ice making device to freeze and/or harvest ice during an ice making freeze/harvest cycle and/or determine the number of freeze/harvest cycles; and generating the status and/or ice production data.

The present invention is also directed to an electronic device which is capable of monitoring an ice making machine having a bin switch and a hot gas valve, the device comprising: a first sensor for determining if the bin switch is either opened or closed; a second sensor for determining if the hot gas valve is on or off; a microprocessor for determining the freeze and/or harvest times for the ice making device to freeze and/or harvest ice during an ice making freeze/harvest cycle and/or for determining the number of freeze/harvest cycles; and a data generator which is capable of producing the status and/or ice production data.

Brief Description of the Drawings

A better understanding of the invention can be had by reference to the following Detailed Description in conjunction with the accompanying Drawings, wherein:

FIG. 1 is an schematic block diagram of the process according to the present invention;

FIG. 2 is a logic flow diagram of the operation of the electronic monitoring device according to the present invention;

FIG. 3 is a logic flow diagram of the operation of a remote computer according to the present invention; and

FIG. 4 is a block diagram of a period report generation scheme according to the present invention.

Detailed Description of the Preferred Embodiment

The present invention is a system and method whereby a commercial ice machine's operational status and ice production is monitored by an electronic monitoring device mounted inside or near the ice machine. This monitoring device periodically communicates the ice machine's status and ice production, via a phone line, the internet, or both, to a remote computer which tracks the ice machine. The user of the monitored ice machine (e.g., a restaurant) would be charged or billed for actual ice produced, as evidenced by the monitored data, rather than buying the ice machine outright. In addition, the monitoring computer would notify a service company and a supplier of ice in the event that a failure of the monitored ice machine was detected.

The method provides a user of ice, e.g., a restaurant, bar, school or the like, with a means to have an ice machine at their facility, but only pay for the ice used. This allows the user to acquire the use of an ice machine without having a large upfront payment. It also allows the user to be assured that he is only paying for ice he's using, and not excess capacity – as he might do if he acquired a large ice machine via a traditional lease. This invention will be particularly attractive to ice users who only need ice during certain times of the week or year (e.g., stadiums, schools).

A further advantage of the present invention is that it provides a means of delivering ice to a user whereby the user does not care if the ice machine's production capacity is oversized. Typically, a user would buy an ice machine with a production capacity that is closely matched to that user's ice consumption requirements, because it is in his economic interest to do so. Buying an oversized ice machine would be an unnecessary added expense. However, because with the present invention the user only pays for ice used, the user is not concerned with the size of the ice machine, as long as it is has sufficient ice production capacity. This allows the ice machine manufacturer / provider to select the ice machine size based on the manufacturer's needs, not the users. Thus for example, the manufacturer may choose to have a smaller array of ice production capacities, since a smaller offering will result in increased manufacturing efficiencies, smaller inventory levels and will facilitate machine servicing (since fewer parts will be needed on the service trucks).

Still yet another advantage relates to a means to detect ice machine failure before it would normally be detected. As stated previously, the end user typically detects ice machine failure when the bin runs out of ice and does not refill. With a monitored ice machine, the monitoring computer could detect failure when the failure occurs, not when the bin runs out. This allows a service call to be made hours earlier than would normally be possible, mitigating the need to buy replacement ice, and minimizing or eliminating any ice shortage to the customer.

The present invention also provides the ability to monitor the amount of ice consumed by the user. This information can be used to predict when or if the user will need a larger ice machine to meet his requirements.

Furthermore, the present invention provides a means whereby the user and/or provider of the ice machine can know when, based on how much ice has been used, the machine will require service. Typically ice machine maintenance is done on a periodic basis regardless of ice used, e.g., cleaning the machine

every six months. The present invention, by monitoring actual ice production and use, can be used to schedule maintenance when it's needed instead of simply when its scheduled.

Another benefit of the present invention is that it allows faster servicing of a failed ice machine. Because the operational history of the ice machine can be provided, via the monitoring computer to the service technician prior to his arrival at the machine, it is possible for the technician to have a good idea of what's wrong with the machine even before he sees it. This knowledge will speed up diagnosis of the machine and thus the service call itself. Likewise, a knowledge of the machine and its most likely problem prior to the visit will allow the technician to be thoroughly prepared, having the right parts to make the repair.

The present invention consists of a conventional ice making machine, an electronic monitoring device, a remote computer and a communication means between the computer and the monitoring device. The monitoring device is connected to components or controls inside the ice machine to allow the monitoring device to know such things as: a) if the ice machine is being requested to make ice (e.g., the ice storage bin is not full), b) how many ice making cycles have occurred, c) the duration of the ice making cycles, including the length of time for both the d) freezing portion of the cycle, and e) harvesting portion of the cycle. With this limited information, it is possible to determine how much ice the machine has made during a given time period and whether or not the machine is operating properly.

On a periodic basis, for example every night, the electronic monitoring device establishes communications with the remote computer via the communications means. It then transfers to the remote computer how many ice making cycles occurred during the prior 24 hours, and the length of the freeze

and harvest cycles and when they occurred, and when the bin was full or not full. The remote computer logs this information.

Logic on board the monitoring device also causes communications with the remote computer to be established when the monitoring device detects a failure of the ice machine. The exact logic used to determine the failure will vary and depend on the size and type of ice machine monitored. In many cases, however, it is possible to detect failure simply by detecting that:

a) The machine is being requested to make ice, AND
b) The length of the freeze portion of the ice making cycle is falling outside the predetermined maximum or minimum time, OR
c) The length of the harvest portion of the ice making cycle is falling outside the predetermined maximum or minimum time.

The information gathered by the remote computer would be used in the following ways:

The information on how many ice making cycles occurred would be used as a basis for billing the user of the ice machine. For example, the ice machine user could be billed based on how many pounds of ice he or she had used in the prior month based on how many ice making cycles were recorded for that time period. By knowing how many pounds of ice are produced each ice making cycle (which is typically a known and consistent number for cube-type ice making machines), it is simply a matter of multiplication to determine how many pounds were generated by a known number of ice making cycles. The dollar amount to be billed to the customer would then be based on the pounds of ice produced and the agreed upon pricing schedule. Preparation of the customer invoices could either be done on the remote computer, or the necessary data could be communicated to a third party to do invoice preparation and delivery.

The communication from the monitoring device to the remote computer indicating a machine failure is used to immediately initiate a request to a service company to repair the ice machine. With a conventional ice machine, the need for a service call typically is not apparent until the ice bin runs empty. This wouldn't happen until many hours, and possibly days, after the failure actually occurred. Because of that time delay, a machine failure will typically result in the end user having to purchase bagged ice until the machine is back up and running and the bin refilled. By initiating the service call immediately upon detection of the failure, it is possible to fix the machine in many cases before the ice bin has been depleted, eliminating (or at least reducing) the need to purchase bagged ice.

Likewise, the failure indication can also be used to initiate a request to a provider of packaged ice to deliver ice to the failed ice machine – thus completely preventing the end user from running out of ice in the event that the machine cannot be repaired immediately.

The information provided by the monitoring device can also be used to speed the repair of the machine. The failure mode (for example the freezing cycle is too long) can be communicated to the service company before they make the service call on the machine. With this failure mode information, and optionally the operating history of the machine, the service technician will have a much better idea about what is potentially wrong with the machine, what to check for, and what parts may be needed.

The logged ice machine operating data can also be used in a number of other ways. For example, ice production histories can be used to anticipate the need for a higher-capacity ice machine before an ice shortage at the end user's facility actually occurs. Ice production history can be used by the end user to track time-of-day, day-of-week, or seasonal ice use. This information might then be used by the end user for staffing, marketing or product development purposes.

Cumulative ice production data could be used to determine when routine maintenance should be scheduled for a given ice machine.

More elaborate monitoring equipment could be used to also track such things as the biological or mineral content of the ice making water, the need to service the water filters that supply the machine, or the need to replace the air filter on a machine.

Although specific embodiments of the present invention will now be described with reference to the drawings, it should be understood that such embodiments are by way of example only and merely illustrative of but a small number of the many possible specific embodiments which can represent applications of the principles of the present invention. Various changes and modifications obvious to one skilled in the art to which the present invention pertains are deemed to be within the spirit, scope and contemplation of the present invention as further defined in the appended claims.

Referring to FIG. **1**, a schematic illustrating the basic components and interconnections of the present invention, a cube-type ice machine **10** is represented. Ice machines of the type that make cubes, such as ice machine **10**, typically contain a device referred to as a hot gas valve **12**. The hot gas valve **12** is used during the harvesting portion of an ice making cycle to direct hot refrigerant into the evaporator of the ice machine to cause the ice to be released. Thus every ice making cycle incorporates a time during which the hot gas valve **12** is energized. An electronic monitoring device **14**, located in or near ice machine **10** is connected to the hot gas valve **12** in order to monitor its operation. Monitoring device **14** captures a number of relevant pieces of data about the ice machine by logging when hot gas valve **12** is energized and when it isn't. For example, the following data can be captured by monitoring the hot gas valve **12**:

- How long the valve **12** is energized = length of the harvest
- How long valve **12** is not energize = length of freeze

- Time between subsequent energizing of valve **12** = length of total freeze cycle
- Number of times energized per day = batches of ice produced per day

In addition to the valve **12**, monitoring device **14** is also connected to bin switch **16**, which is used to control when the ice machine turns off. There are a number of ways for a device such as bin switch **16** to work, for example ice machine manufacturers have used mechanical switches, thermostats, and electric eyes to accomplish the bin switch **16** function. By monitoring the status of bin switch **16**, monitoring device **14** can determine if the ice machine **10** should be running or not. This information is critical in determining if the ice machine **10** is operating properly.

On some regular basis, for example daily, monitoring device **14** initiates communications with a remote computer **20**. The communication is accomplished using a communication means **22**. Communication means **22** can be accomplished through a number of different methods, for example, a phone line (i.e., dial-up) type connection directly to computer **20** or a phone line to an Internet connection that would be used to communicate to computer **20**. Communication means **22** can be a connection to the internet using a DSL line, T1, cable internet, wireless (e.g., wi-fi) or any other suitable means to connect to the internet.

Information to be communicated on a regular basis from monitoring device **14** to computer **20** include ice production information, and ideally all the operating information monitored and logged by device **14**. With that information, computer **20** can determine the amount of ice produced over any given time period by ice machine **10**, and is also capable of reporting the complete usage and operational history of machine **10**. As stated previously, this information is beneficial for a number of purposes, including speeding service

calls, predicting the need to increase production capacity, and for the end user to better understand his usage patterns and trends.

Using the ice production data from ice machine **10**, computer **20** can either generate invoices **30** that would be sent to the end user **40** or owner of ice machine **10** or transmit the production data to a third party for invoice generation. Invoices **30** charge the end user **40** for ice based on that end user's **40** actual use of ice, as evidenced by the production data from the ice machine **10**. This would be the means by which the end user **40** would pay for the use of the ice machine.

In the event that monitoring device **14** detected a failure in ice machine **10**, device **14** would immediately initiate communications with computer **20** via communication means **22**. Device **14** would communicate to computer **20** that a failure had been detected in ice machine **10**. Ideally, device **14** would also communicate to computer **20** what the mode of failure was. For example, these modes may include:

Freeze cycle too long (i.e., greater than the predetermined maximum)
Freeze cycle too short (i.e., less than the predetermined minimum)
Harvest cycle too long (i.e., greater than the predetermined maximum)
Harvest cycle too short (i.e., less than the predetermined minimum)

Device **14** may additionally communicate all performance data since the previous communication with computer **20**, so that computer **20** has all the relevant performance history up until the time of failure.

At this time, communication would be initiated from the remote computer **20** to a service company **32** who would be instructed to make a service call to ice machine **10**. That instruction may be done automatically by computer **20** or through some other means, for example via a human operator of computer **20**. Ideally service company **32** would be provided with details available on machine

10, including the mode of failure and its recent operating history. This information would be useful in the diagnosis and repair of the machine **10**. At this time, a bagged ice supplier **34** may also be contacted to provide bagged ice to the end user to insure that he does not run out of ice.

Figures 2-4 relate to various flow diagrams for controlling electronic monitoring device 14, remote computer 20 and the periodic report generator of the present invention.

Operation of Electronic Monitoring Device

The preferred operation of electronic monitoring device **14** is set forth in Fig. 2, wherein device 14 is connected to hot gas valve **12** and bin switch **16** of ice machine **10** so the operation of machine **10** can be monitored. Software within device **14** operates as shown in Fig. 2 and as described below.

During operation, device **14** would continually monitor the status **50** of bin switch **16** in order to determine if the ice machine is supposed to be running. If the ice bin (or ice dispenser) below ice machine **10** is full, then bin switch **16** will be open (typically), causing the ice machine to turn off. Thus, if switch **16** is open, the ice machine **10** should be off with no monitoring needed. Status monitor **50** will then continuously check to ensure that switch **16** is open. Conversely, if switch **16** is closed, ice machine **10** should be on and operating, and should be monitored by device **14**. If status monitor **50** determines that switch **16** is 'closed', then electronic monitoring device **14** checks to determine if hot gas valve **12** is 'ON' **52**.

If hot gas valve **12** is ON (energized), machine **10** is executing an ice harvesting sequence. If this is the case, device **14** will track **54** the time that valve **12** stays energized (the Harvest time), record that time into memory, and check the Harvest time to be sure its within the prescribed parameters, i.e., not longer that the predetermined MAX time, and not less than the predetermined

MIN time. If the Harvest time is outside of the predetermined MAX range **56**, device **14** will be instructed to immediately perform a Call-out function **58**, whereby it makes a connection to remote computer **20** and uploads all data stored since the last Call-out (e.g., cycle times, cycle counts, machine ID) alert computer **20** that the Harvest time was either shorter or longer than the predetermined limits. If the Harvest time is not outside the predetermined MAX range, then it checks to see if the Harvest time is outside of the predetermined MIN range 60. If the Harvest time is outside the MIN range, then it performs Call-out function step **58**. If the Harvest time is neither outside of the predetermined MAX or MIN ranges, then device **14** checks to determine if the predetermined time to call-out has been met **62**. If the predetermined time to call-out has not been met, then device **14** returns to step **50** to determine again if the bin switch is 'closed'. If the predetermined time to call-out has been met, then device **14** performs call-out step **64** which uploads cycle times, uploads cycle count and indicates that the unit is okay to remote computer **20**. After call-out step 64 is performed, device **14** returns to step **50** and the sequence of monitoring control steps is performed again.

If hot gas valve **12** is OFF (de-energized), and bin switch **16** is CLOSED, one can assume that machine **10** is in the freeze portion of an ice-making cycle. In this case device **14** would record the Freeze time into memory **66** and thereafter determine if the Freeze time is greater than a predetermined MAX time limit **68**. If the freeze time is greater than a predetermined MAX time limit **68**, then, device **14** would be instructed to immediately perform a Call-out function **70**. As described above, device **14** would connect to computer **20** and upload all data stored since the last Call-out (e.g., cycle times, cycle counts, machine ID) alert computer **20** that the Freeze time was either shorter or longer than the predetermined limits. If the Freeze time is not greater than a predetermined MAX time limit **68**, then the system determines if the Freeze time is below a predetermined MIN time limit **72**. If the Freeze time is below the predetermined MIN time limit **72**, then the device **14** would be instructed to immediately

perform Call-out function **70**. After performing Call-out function **70**, then system returns to step **50** and starts all over. If the Freeze time is not above the predetermined MAX limit nor below the predetermined MIN limit, then device **14** will determine if it is the predetermined time and predetermined schedule to call-out **62**. If it meets the predetermined time to call-out **62**, then the system performs a call-out **64**, including uploading of cycle times, uploading of cycle count and stating that the unit is okay. For example, it might be programmed to call-out every night at 3:00AM or every Sunday at 1:00AM. If the predetermined time to call-out **62** has not been met, then the system returns to step 50 and starts the monitoring of the system again.

Operation of Remote Computer

The operation of remote computer **20** is described in Fig. 3, attached hereto, wherein remote computer **20** receives communications **80** from electronic monitoring device **14** and take predetermined actions based on the information received. The communications may include a data packet having device identification, cycle times, cycle count and unit status (okay or not okay). Data may be received from device **14** via communication means **22** which may include an internet communication (e.g., email), a direct dial-up (modem) connection, wireless communication or any other communication method now known or developed in the future which is capable of transmitting such communications **80** from device **14** to remote computer **20**. Data communicated to computer **20** may be, but is not limited to, the identification of the ice machine **10**, a log of the freeze and harvest times recorded by device **14**, a total of cycles recorded since the last communication and the status of the unit (e.g., unit okay, unit NOT okay: harvest too long, harvest too short, freeze too long or freeze too short).

The data packet or communication received by remote computer **20** is then checked to determine if it is okay **82**. If the communication from step **80** includes an alert that ice machine **10** was NOT okay, remote computer **20** would transmit a notification **84** to designated service personnel alerting them to the

problem and communicating the information needed. Such information would include machine information (i.e., location, model & serial number, owner contact information), the latest operating data log and suggested problems, and parts needed based on model number and failure mode. The designated service personnel could include any or all of: the owner/customer, the designated service company and/or an ice delivery service. This would allow the designated service provider to immediately visit the machine, making any needed repairs prior to the customer actually running out of ice. Alerting an ice delivery service of the machine failure would allow ice to be delivered to the machine location to insure that there was a sufficient supply of ice even if the machine could not be repaired immediately.

If the status of the ice machine **10** was "okay", then this protocol procedure is done **86** and no further action would be taken at time of data receipt.

Fig. 4 describes the periodic report generation features of the present invention. Remote computer **20** periodically generates predetermined reports 88 desired for ice machine **10**. Such reports could include, but are not limited to, graphs and statistics of operating performance. The reports may also include invoices to the customer charging that customer for actual pounds of ice produced by the machine **10**. Such reports may optionally be communicated or transmitted **90** to designated personnel, such as the machine owner (e.g., a leasing company), machine user/customer (e.g., a restaurant), and/or machine service provider.